Concept Experimentation Program

CEP 00-CEP0103-1

Out of Theater High Frequency Radio Relay Concept Experiment

Proponent: United States Army Aviation Center, Directorate of Combat Developments
Sponsor: Training and Doctrine Command's Air Maneuver Battle Laboratory (AMBL)
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Table of Contents:

1. Purpose.

a. Army aviation has acquired new high frequency nap-of-the-earth communications (HF NOE COM) radios, the AN/VRC-100 and AN/ARC-220. Fielding of this radio is ongoing to Army's aviation utility and cargo helicopter fleet. Attack and reconnaissance helicopter installations will follow-on. During the conduct of the developmental and operational tests for this radio, combat developer (DCD) and testing community observed that radio performance suffered at night due to the difficulty of getting radio frequencies to reflect off the ionosphere in the near vertical incident sky-wave path. A different approach to HF communications, i.e. using radio relays positioned several hundreds of miles away from the transmitter, may improve the throughput of HF communications specifically at night. These stations can be located out of theater thereby allowing the erection of focused antennas and high power amplifiers that will increase the gain in a fixed site using commercial power. Such a station must be set up in a sanctuary where it is not a victim of hostile threat activity and it must have good communications back into theater with telephone, satellite, or HF radio in order to relay the messages to aircraft or ground stations.

b. This "experiment" does not conform to the rigorous scientific method and analysis of a "test." Conclusions therefore are estimates and can not be used to define expected performance. The experiment's purpose was to determine whether Army aviation should pursue a formal testing of various antennas, power amplifiers, and techniques to institute a HF Out of Theater doctrine for non-line-of-sight communications.

2. Scope:

This experiment was designed to use the various modes of operation of the AN/VRC-100 and AN/ARC-220 HF radios that Army aviation would typically use in peacetime, stability and support operations (SASO), and theater of war. The experiment used realistic distances between aircraft, ground relay stations, and tactical operations centers. The sanctuary station used in this experiment was Rockwell Collins' Communications Central (COM Central) located in Cedar Rapids IA. This facility represents a typical fixed base sanctuary that has or can erect the necessary antennas, amplifiers and equipment. It is located in a host country that offers relative security from threat attacks. The cost of creating an unmanned remotely controlled sanctuary station turned out to be too costly to meet the funding restraints of this CEP. Instead the sanctuary station was manned with soldiers who used the telephone to relay information.

3. Concept:

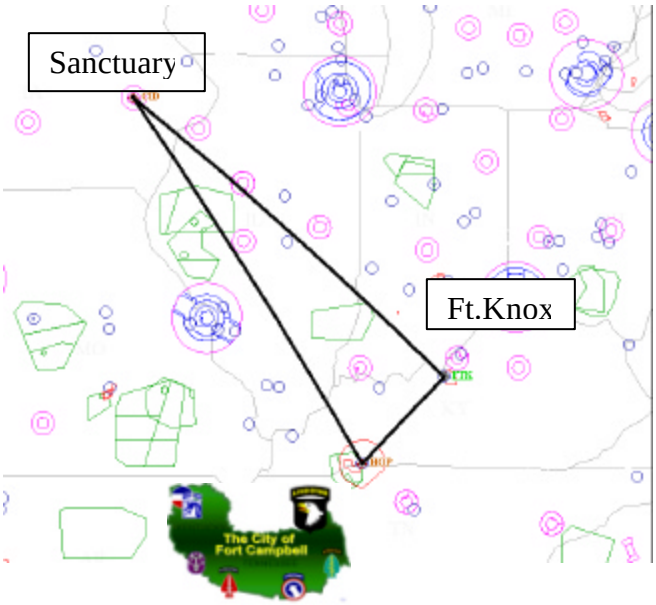
a. Description:

The concept of the experiment was to fly two aircraft (representing two flights of aircraft) between Fort Campbell Kentucky and Fort Knox Kentucky, make radio calls at intermediate points on the way up and on the way back. Each radio call would be made twice; once to the TOC at Fort Campbell and immediately following, the same call to the Sanctuary station at Cedar Rapids, Iowa. Four data collectors were needed to log all the calls then determine the success of these calls.

b. Scenario:

The scenario chosen for this experiment was to exemplify a typical air assault mission with reporting points and typical distances to travel.

The attack elements of the 101st Aviation Brigade are planning a deep attack 15 miles North North West of Fort Knox to attrite the threat forces of the 449th combined mechanized regiment which is expected to pass through this region at 0100 Greenwich. The 159th Aviation Brigade has been given a mission to conduct an artillery raid into Fort Knox of a 155 towed artillery battery with ammunition and personnel. This battery will be in direct support of the deep attack. Fort Knox is not occupied by enemy forces but the division commander wants to provide security for this artillery battery and has tasked 3d Infantry brigade to air assault a company of infantry into the Fort Knox landing zones to clear the LZ, mark the landing zone, and set up perimeter defenses for the battery. The infantry will air assault 30 minutes prior to the artillery raid. The raid is expected to support the deep attack for two hours then be air assaulted back to Fort Campbell. See map at annex A. The sanctuary station is located off the map to the North West in the American Embassy in a country friendly to the United States. The raid is very risky so the commander wants the flights to report every phase line, arrival, departure and every phase line on the return trip.



Each flight leader, UH-60 air assault, and CH-47 raid aircraft, has designated his number three aircraft in the flight (chalk three) to make the reports as prescribed by the commander via HF radio. The lead aircraft, commander of the flight, will direct formations, landing direction, turns etc. within the flight using UHF radio. He will talk to the units at the LZ, pathfinders or long-range surveillance units on the ground via SINCGARS, and he will also perform primary navigation. The second aircraft in the flight is alternate for navigation and will make all radio calls for passage of lines (SINCGARS) and air traffic control reports (VHF-AM). The third aircraft handles the prescribed reports to the TOC for such things as lifting SEAD, position reports, and situation reports via HF. The other aircraft in the flight are back up for these primary communications duties.

c. Rationale:

This scenario highlights the expected use of the HF radio in SASO and theater of war operations; calling for raids and air assaults of soldiers into remote areas beyond the range of line of sight

radios to ground maneuver units. In SASO, often times civilians, such as embassy personnel and dignitaries are flown into certain regions to make assessments. Often a security team flying in ahead to clear the landing zone and establish security precedes these flights. Flights of aircraft use their line of sight radios to communicate with each other and ground units that they support. When they are beyond the range of their line-of-sight radios, they use their HF radio to make position and status reports to their own TOCs in order to trigger events or to keep them informed.

4. Precedence.

a. The idea of a sanctuary station is new to Army aviation. Traditionally, Army aviation has placed several TOCs [Main Tactical Operations Center (TOC), Tactical Command Post (TAACP), and Air Logistics Center (ALOC)] on the battlefield. The TACCP was placed out front in line-of-sight communications distance with maneuver aircraft, usually in a UH-60. The TOC was farther back since communications with high headquarters takes precedence. The ALOC is located near the division airfield. Through the years Army aviation units have used various methods of linking these geographically dispersed elements of an aviation command. High frequency radio, satellite communications (SATCOM), mobile subscriber equipment (MSE), radio relays, have not been very effective. Of these methods, high frequency radio appears to be the best alternative since aviation commanders own the equipment, all utility and cargo aircraft have radios, frequencies are available, the system is secure and protected from electronic counter measures.

b. Using the HF system as a substitute for a line-of-sight radio will not work. The throughput on HF is much slower and is prone to error because of the difficult path HF signals must travel. Developers have produced special technical means to increase the probability of successful HF communications. These technical means slow the connection time and delay communications significantly. Commanders must limit the use of HF to very specific reports that must get through and only when line of sight radio cannot due the job.

c. Other users of HF radios have established out of theater stations and procedures that optimize the use of their radios. The following are three examples.

(1) The Army Corps of Engineers uses HF ALE radios for an internal nationwide net. Corps of Engineer base stations are located throughout the Continental United States and in Alaska and Hawaii. They use the HF ALE net on a weekly basis for operator training and exercising the net. The Corps of Engineers have mobile HF stations as well which can link with any of these fixed (sanctuary sites). This distances between sites vary from several hundred miles to thousands of miles; ideal for HF communications.

(2) The U.S. Air Force operates Scope Command (http://www.idg.net/crd_scope_85260.html) which is a series of 14 stations throughout the world that all operate on the same set of frequencies. This network is used to communicate with Air Force cargo, tankers, AWACS, and other utility aircraft to include Air Force 1 and Air Force 2. The principal mode of operation now is voice but will soon go to all data and e-mail with the

introduction of HF messenger into this system. All the ground stations operate unmanned and are controlled from a central location in Andrews AFB Washington DC. Aircraft connect with the ground station that provides the optimum distance for clear communications.

(3) The U.S. Custom Service operates a series of 10 or more ground stations on fixed frequencies throughout the central United States. These stations have directional antennas oriented to the southern borders. These stations are unmanned and operate from a remote control unit that are portable and can be anywhere there is a phone jack. Aircraft radios are ALE and connect with the ground station that has the best link quality. The most interesting attribute of the U.S. Customs systems is that the radio operators just have to turn their radios on. All transmission encryption, frequency selection, maintenance troubleshooting etc is done by the central control facility in Orlando Florida. This facility can data link to the radios and establish all the parameters for the crew members so all he has to do is push to talk. Locating the transmission sites throughout the central U.S. takes advantage of the long skip of 1000 miles between stations and increases throughput.

5. Conduct of the Experiment

a. Stations.

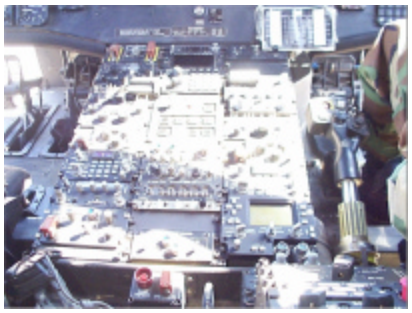
The OOTC experiment was conducted at Fort Campbell, Fort Knox, and Cedar Rapids Iowa. Cedar Rapids was the sanctuary location. Fort Campbell the TOC location, and the Fort Knox was the landing zone or objective location. Two aircraft flew from Ft. Campbell to Ft. Knox and returned, transmitting messages via HF in both directions at prescribed points in the route.

(1) Rockwell International operated a sanctuary station in Cedar Rapids, using a VRC-100 radio, KY-100 crypto device, LFH230/1 FanLite transportable antenna, CYZ-10 data transfer device (DTD) with Automated Network Control Device (ANCD) software (version 2.08), PSN-11 portable light weight global positioning system receiver (PLGR)., and Collins 273B-1 log periodic antenna. The 159th Aviation brigade sent two soldiers to Rockwell's communications central in Cedar Rapids to act as radio operators and data collectors for the experiment.

(2) Vitronics set up a simulated TOC in the 7th battalion 101st aviation (7-101) regiment's headquarters building on Fort Campbell, which is near Campbell Army Airfield, the pickup zone for this experiment. Vitronics used a FanLite antenna provided by the 7-101, five VRC-100 radios with dummy loads provided by the 1st Aviation Brigade at Fort Rucker, Alabama. Two KY-100, one AN/PSN-11 provided by 7-101, and two cable sets provided by CECOM. Vitronics used the five radios primarily for training. Only one was used for operations. Two Vitronics personnel and two 159th Aviation

brigade personnel acted as radio operators and data collectors at the simulated TOC.

(3) The 5-101 and the 7-101 provided a UH-60 and CH-47 with crews each day for experimental runs. Each aircraft was outfitted with one ARC-220, KY-100, and shorted loop antenna. Aircraft had standard configuration that included the battery holdup box for the radio memory and connections to the doppler global positioning system navigation system (DGNS). In addition to the air-crews, two soldiers from the Test and Experimentation Command at Fort Hood were assigned as data collectors on board these aircraft.



b. Data Collectors.

The data collection plan was to thoroughly train the operators on the radio and the planners on the HF-CPS software. Have the planners create the data base, load the aircraft then fly an afternoon and a night flight each day for four days; make position reports using various modes of the radio to both the TOC and the sanctuary station. Each data collector would take notes on the success of the radio call, the frequency the radio connected on, and the general operation of the radio in the aircraft.

c. Conduct of the Experiment.

The first week was spent on set up of the TOC, the sanctuary station, and training. Training began on Tuesday 19 Sep 00. The classroom was full of battalion communications personnel and aviators. Operator training was conducted on Tuesday and Wednesday morning this included some tactics techniques and procedures (TTP) training. Planner training, including TTP, HF-CPS, radio propagation, frequency assignment, and individual address associations were conducted on Wednesday, through Friday. Mostly 31U, officers and NCOs from the various battalions in the 159th participated. The training was determined to be very satisfactory. There was a lot of interest in the materiel presented a lot of questions were asked and several personnel got comfortable with HF-CPS software.

d. Un-programmed Training.

Additional training was conducted on 27 September. The 5-101 pilots quickly learned that the radio worked and reported this to their company commander. The commander scheduled two hours of training on Wednesday for his entire company of aviators. This was accomplished on Wednesday morning before the afternoon runs.

e. Players.

B Co, 5-101 (UH-60) used many different crews for the experiment, one day crew and one night crew. and they used different crews each day. This was to avoid any problems with aviator crew rest and to get as much exposure to the radio as they could. The 7-101 (CH-47) on the other hand used one crew each day which did cause problems with the crew work day, in that crews could not fly the whole night mission on Tuesday 26 Sep 00 because delays in getting the aircraft airworthy and airborne cut into the to crew work day. The CH-47 HF equipment had been installed last year. Batteries in the battery hold up boxes were dead and some of the KY-100s

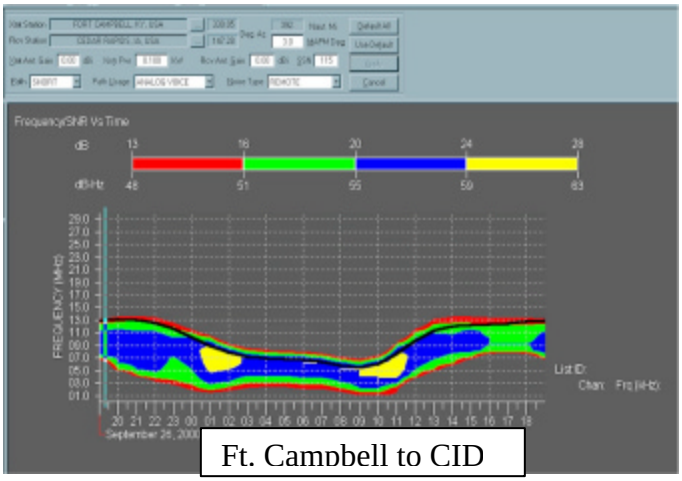
were not connected, properly programmed, nor had batteries installed. It was apparent that the 7-101 was not using their ARC-220 for anything other than perhaps single channel HF non-secure. Without an KY-100 connected it could not be used in any mode . The KY-100 completes the key and audio lines for the ARC-220. The CH-47 installation uses the remote box for the KY-100. This means the KY-100 in the radio bay must be set to "remote" position. The UH-60 had a new installation. The batteries were fresh, KY-100 was set properly and everything worked. Both aircraft had low audio on the KY-100 both plain text and cipher text. The audio settings were manually set too low for proper audio levels in the UH-60 and CH-47 crew station environment during flight. This proved to be troublesome during the voice runs.

f. Base Station.

The base station at Cedar Rapids and Fort Campbell was composed of a VRC-100, PSN-11, KY-100, FanLite antenna, battery hold up box, and cable. The cable was borrowed from CECOM and costs $1300.00 (NSN 5995-01-476-4130). This cable enables the VRC-100 to be removed from the High Mobility Multipurpose Wheeled Vehicle (HMMWV) and operate, remotely, secure, ECCM, and link protection in an office environment with KY-100, PSN-11, battery hold up box, and low speed binary hook up to a computer. The picture at right shows the set up of the TOC at Fort Campbell. All equipment was removed from the HMMWV in which it was installed except for the cable and notebook computer. At $1300 the cable is a significant expense for the unit. Dismounted, there is no place to mount the KY-100 or PSN-11 or battery hold up box. For garrison operation, remoting the radio from the HMMWV is not an available option. The Communications and Electronics Command (CECOM) has the information and documentation to remote control the radio using common field wire and a computer's RS-232 connector but the software for this has not been developed completely.

g. Antennas.

The sanctuary station at Cedar Rapids used the FanLite antenna for the first day then switched to the Log Periodic for the remainder of the experiment. The log periodic antenna has a frequency range of between 6 mhz and 30 mhz. This is not viewed as a problem since the radio will tune the antenna to make it usable below 6 mhz. Further, due to the distance, frequencies below 6 mhz were probably not optimum even at night for this experiment. Using the Log Periodic focuses the RF energy in one direction and is typically an antenna used at fixed station sites with unidirectional communications requirement.

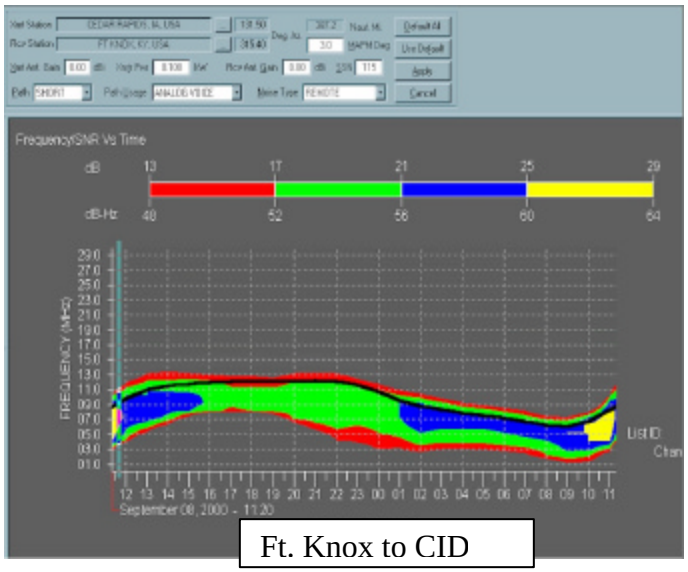


Ft. Campbell to CID

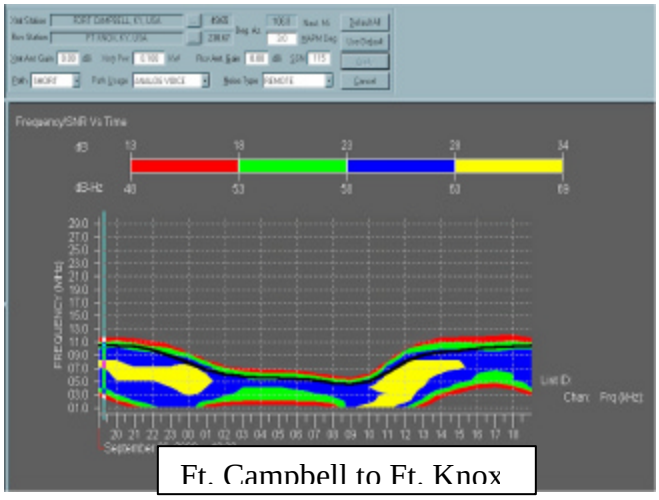
h. Frequency Acquisition.

Vitronics acquired the frequencies used for this experiment from the Army Frequency Management Officer (AFMO) Continental United States (CONUS). Early in 2000, Army aviation representatives approached AFMO CONUS to provide a set of HF frequencies for Army installations. AFMO CONUS responded by issuing three sets of frequencies, covering the 2 to 30 MHZ range, for the three separate regions in CONUS. Since Cedar Rapids is in Region 5 and Fort Campbell and Ft. Knox are in Region 1, a set that had shared frequencies was devised for this experiment.

i. Frequency selection. The Army Frequency Management Office for Continental United States (AFMO CONUS) issued Army aviation HF frequencies for use throughout CONUS. Vitronics used Prop Man® software, a Rockwell Collins product, to predict the frequencies for optimum transmission based on a number of parameters. Vitronics considered three different path lengths, Cedar Rapids to Ft. Campbell, Cedar Rapids to Ft. Knox, and Ft. Knox to Ft Campbell (see illustrations). The Cedar Rapids to Ft. Campbell and Cedar Rapids to Ft. Knox are virtually identical. The Ft. Knox to Ft. Campbell is slightly lower in frequency over all than the Ft. Campbell to CID band. The parameters chosen for Prop Man® were:



Ft. Knox to CID



Ft. Campbell to Ft. Knox

(1) Zero antenna gain. The FanLite has minus antenna gain below 6 MHZ but positive gain above 8 MHZ . Zero was the compromise.

(2) Sunspot number chosen was from the world wide web http://www.sunspotcycle.com/. Prop Man will automatically fill in a sunspot number based on the host computer date. This is a predicted number based on historical data.

(3) The path usage was set to "Analog Voice." This was the second worst case usage; digital voice was the worst case; AMD messages was the best case.

(4) Transmitter gain was set to zero to match the receiver gain since both transmit and receive use the same antenna.

(5) Transmit power was set to 0.1 KW consistent with the ARC-220.

(6) The noise parameter was set to "normal." Other parameters were rural, city, industrial, custom. Industrial being the worst case, rural being the best.

(7) The path "short" for the most efficient means. Shortest path uses the "great circle method."

Vitronics picked frequencies between the MUF and LUF of the Cedar Rapids to Ft. Campbell, and Ft. Campbell to Ft. Knox range. With ALE propagation prediction becomes much easier. A quick look at Prop Man indicates that frequencies above 13 MHZ do not propagate and frequencies below 1 MHZ do not propagate. But frequencies between 3 and 13 MHZ will work for day and night and multiple paths. Vitronics did not choose any two MHZ frequencies because of the noise factor. Especially at night frequencies below four MHZ are very noisy, from atmospheric and exo-atmospheric activity, that they become practically unusable. In view of this the following frequencies were chosen for ALE during this experiment:

ALE Scan List used for the experiment

Frequency
3.1370
4.6415
4.7900
6.7210
7.3615
8.1715
10.8210
12.1680

What was not done was to listen to these selections weeks ahead of time to determine if any of these frequencies was excessively noisy. Based on our observations, this should have been done. The 7.3615 frequency was never used by the radios in ALE mode during the experiment. It turns out that this frequency is consistently very noisy this time of year and ALE could not give it a very high link quality number; lesson learned. ECCM frequencies were chosen with center frequencies as follows: 3.5800 night, 7.5000 transition, 10.2000 day. These appeared to be the frequencies closest to the frequency of optimum transmission for the Ft. Campbell to Ft. Knox.

6. Data Collection.

The second week of the experiment was dedicated to collecting data. The proposed data collection program was as follows:

Data Collection Program

Day	Method of Communications	Mode of Communications	Security	Link Protection
25 Sep Day	Voice	ALE	Plain Text	No
25 Sep Night	Data Messages	ALE	Plain Text	No
26 Sep Day	Voice	ALE	Cypher	Yes
26 Sep Night	Voice	ALE	Cypher	Yes
27 Sep Day	Position Reports	ALE	Cypher	No
27 Sep Night	Data Messages	ALE	Cypher	Yes

Day	Method of Communications	Mode of Communications	Security	Link Protection
28 Sep Day	Voice	ECCM	Cypher	No
28 Sep Night	Position Reports	ECCM	Cypher	No
29 Sep	Backup for weather or maintenance			

a. Day 1, 25 Sep 00.

This was scheduled to be the first day of the experiment gathering. Foggy weather all day forced cancellation of the flights. The base station at HOP and CID conducted some radio checks. We discovered that the radios had software version 1 and therefore link protection did not work correctly. So we decided to work the rest of the test without link protection. We also used the time to conduct more training on HF-CPS, created data fills of various types and loading radios, and testing these loads with CID station.

b. Day 2, 26 Sep 00.

This turned out to be the first day of data collection and we had to revise the collection program. In the end the following is the collection program we followed.

Final Data Collection Program:

Date	Time	Type of Communications	Aircraft
26 Sep	1500-1600	ALE Voice PT	UH-60
26 Sep	1600-1735	ALE Voice CT	UH-60/CH-47
27 Sep	1500-1600	ALE Position CT	UH-60/CH-47
27 Sep	1715-1810	ALE Message CT	UH-60/CH-47
28 Sep	1600-1800	ECCM Voice CT	UH-60/CH-47
28 Sep	1900-2200	ECCM MSG CT	UH-60/CH-47

(1) The following table shows the distance between point in the experiment. Four phase lines were created between Fort Campbell and Fort Knox. These phase lines were named. Crews reported the pickup zone departure, each phase line, the landing zone arrival, landing zone departure, and each phase line on return to the pickup zone.

Distance Table

Waypoint	Waypoint	Distance NM
HOP	LZ Cat (FTK)	104
HOP	PL Orange	26
HOP	PL Yellow	45
HOP	PL Red	61

Waypoint	Waypoint	Distance NM
HOP	PL Blue	76
FTK	PL Blue	26
FTK	PL Red	43
FTK	PL Yellow	59
FTK	PL Orange	78
FTK	PZ Bear (HOP)	104
CID	PL Orange	361
CID	PL Yellow	358
CID	PL Red	357
CID	PL Blue	355
CID	LZ CAT (FTK)	356
CID	PZ Bear (HOP)	369

(2) The transcribed data sheets from the data collectors are at Annex A. The following table is the summary of the data collection on 26 Sep 00. The CH-47D missed the day flight due to aircraft maintenance problems. It flew the night mission but could not complete the night mission due to crew rest limitations.

DAY ALE Plain Text and Cipher Text Voice

Receiving Station	No Attempts	No Complete	% Complete	No Frequencies Used
In Theater (Campbell)	12	11	91.6	5
Out of Theater (CID)	12	12	100	1

NIGHT ALE Plain Text and Cipher text Voice

Receive Station	No Attempts	No Complete	% Complete	No Frequencies used
In Theater (Campbell)	19	12	63.1	6
Out of Theater (CID)	19	15	78.9	3

(3) The sanctuary percentage complete was higher and the sanctuary used fewer frequencies. This is consistent with the prediction that a sanctuary station offers better throughput. It also shows that ALE is very important for Army aviation missions in theater.

c. Day 3, 27 Sep 00.

The third day was all cipher voice and data. The radio is not able to send data at all in the plain text mode while the KY-100 is hooked up. So we ran all missions in the secure mode. Below are the results of the second data-gathering day's activities.

DAY, cipher, GPS position reports, ALE 300 bps

Receiving Station	No Attempts	No Complete	% Complete	No Frequencies Used
In Theater (HOP)	12	12	100	5
Out of Theater (CID)	12	12	100	4

NIGHT, cipher, data messages, ALE 300 bps

Receiving Station	No Attempts	No Complete	% Complete	No Frequencies used
In Theater (HOP)	24	21	87.5	7
Out of Theater (CID)	24	21	87.5	6

These tables show no difference between the success rate to sanctuary verses in-theater-station. All reports were sent data. The day reports were GPS position reports, the night reports were data messages. There was not significant difference in frequency selection either; although the frequencies to the sanctuary were all higher.

d. Day 4, 28 Sep 00.

All of the reports were sent via ECCM. The day reports were send ECCM voice and the night reports ECCM data.

DAY ECCM, cipher, voice, (10.2 MHZ)

Receiving Station	No Attempts	No Complete	% Complete	# Frequencies Used
In Theater (HOP)	24	13*	54.1	1
Out of Theater (CID)	24	22*	91.7	1

*The ground stations hear the aircraft reports but the aircraft did not always hear the acknowledgements from the ground station. These reports were counted as half a complete report.

NIGHT ECCM, cipher, data (10.2 MHZ)

Receiving Station	No Attempts	No Complete	% Complete	# Frequencies used
In theater (HOP)	24	12	50.0	1
Out of theater (CID)	24	10	41.7	1

(1) The following is background on ECCM mode of operation. The radio provides analog voice from the microphone to the KY-100 which codes the voice into data at a rate of 2400 bits per second. This data is then buffered by the KY-100 and sent to the radio as the radio

asks for it. In ECCM the radio must turn off the transmitter, retune the radio to a new frequency, then turn on the transmitter to send more data. This is usually transparent to the user since the decoder at the receive end restores the audio back to its original format and will not deliver it to a loud speaker until it is compete. What was heard during the day was clear voice traffic at CID and HOP. The aircraft had trouble hearing the responses from HOP and CID acknowledging receipt of the message. We view this as a probable technical problem with the radio's audio level as it was installed on the aircraft. However, the data reflects the facts of the situation.

(2) The figures show an advantage to the sanctuary station in the day but not at night. The CH-47D was not heard at all on the night mission although it faithfully executed each and every call. Communications was so ineffective at night that the UH-60 switched back to ALE to try a contact and the station at HOP did the same instructing the station at CID to remain in the ECCM mode. This "diplex mode" actually helped; although the crews were not briefed on this contingency plan. The UH-60 crew realized they had to try something else since ECCM was not working. This was a lesson learned: Return to ALE plain text voice when ECCM or other modes are not working. If two base stations are on the air i.e. TOC and sanctuary have one working ALE, the other ECCM both bases are covered and the probability of communications increases. The reason communications was very ineffective at night was because the frequency was not changed from the day set. The day set (10.2 Mhz) worked very well; so well in fact that the 159th did not want to change. Caution was advised: 10.2 Mhz center frequency will not work as well at night The 159th decided to use the 10.2 mhz frequency set and let the test go on with the 10.2 Mhz frequency set. We had a 7.5 Mhz and a 3.5 Mhz set programmed into the radio. The plan was to use the 7.5 mhz set. As a result of this choice ECCM at night was very poor. So poor in fact it should not be factored in.

e. Overall results

There is a slight advantage to having an out of theater "sanctuary" station. The difference between night operations and day operations is only slight. This is the first time the Aviation center has had a chance to evaluate the FanLite and ARC-220 together in an operational environment with operational aircraft. The measured outcome was better than the Operational Test (OT) results that showed a 65% throughput. The OT was conducted at the bottom of the sunspot cycle whereas this experiment was conducted at the peak of the cycle. Further this experiment was conducted with the FanLite antenna considered to be a superior antenna to the one used in the OT. It is therefore hard to make comparisons

Overall Results

Receiving Station	No. Attempts	No Complete	% Complete
In Theater (HOP)	115	89	77.0%
Out of Theater (CIC)	115	92	80.0%

Overall Results when ECCM Night Trials Eliminated

Receiving Station	No. Attempts	No Complete	% Complete
In Theater (HOP)	91	76	83.5%
Out of Theater (CIC)	91	82	90.1%

Overall Night Results

Receiving Station	No. Attempts	No Complete	% Complete
In Theater (HOP)	67	52	77.6%
Out of Theater (CIC)	67	46	80.0%

Overall Day Results

Receiving Station	No. Attempts	No Complete	% Complete
In Theater (HOP)	48	36	75.0%
Out of Theater (CIC)	48	46	95.8%

7. Conclusions

a. Army aviation should not pursue formal testing of various antennas and power amplifiers. Existing antennas (FanLite) and radio power amplifier exhibit adequate performance.

b. Operating a sanctuary station does help in completing communications for Army aviation but it is not a significant enough advantage to change doctrine. Traditional methods of operating HF stations in theater, alongside the TOC, work satisfactorily.

c. Sanctuary stations should be considered when:

(1) Very few frequencies are available i.e. one for day and one for night. A sanctuary station suffers less from ionospheric disturbances than a close in station. They also allow the use of higher frequencies that are quieter and typically more available.

(2) Simultaneous (duplex mode) operations. Sanctuary stations offer duplex mode of operations i.e. one ECCM and one ALE.

(3) Fail Safe operations. When commanders absolutely have to achieve the highest probability of communications, ALE data secure is the best mode of operation with a sanctuary station in place and on the air.

d. Automating a sanctuary station could not be accomplished during this CEP due to the cost of materiel and software. Soldiers are still required to man the station even when automated for the purpose of setup, maintenance, and security.

8. Recommendations:

That the United States Army Aviation Center not alter doctrine to reflect the need for sanctuary stations. Rather, change the Tactics Techniques and Procedures (TTP) manual by including the planning considerations for opening and operating a sanctuary station if ever needed. This is to offer the commander recommendations for the equipment and methodologies

for increasing his probability of communications with HF given certain mission, enemy, terrain, time, funding, and frequency assignment limitations.

9. Observations/Issues:

a. The initial observation made during this experiment was the lack of training of the personnel in the 159th Aviation Brigade at Fort Campbell on the HF equipment, TTP, antennas, KY-100, and HF-CPS software. I suspect this is a pervasive problem throughout Army aviation, particularly in view of the fact that the 159th aviation brigade was very enthusiastic with a real desire to solve their non-line-of-sight radio problems. Previous attempts to solve this problem led the 159th to procure eight PRC-138 HF radios from Harris corporation which they have not put into operation as yet. These radios came with little training, no COMSEC, and no way to load them with a data transfer device. The communications personnel at the 159th were hungry for information about the ARC-220, CYZ-10 (ANCD), HF-CPS, and VRC-100. They were very attentive in class, asked a lot of questions, and worked the practical exercises in earnest. They learned HF-CPS and were using it when the OOTC experiment team left. The data base that was previously prepared for them was still at the G6 level. It was never passed down to the aviation brigade. Training in earnest must be conducted once the units have several radios installed in aircraft. They will then be able to use the radio right away. Training should include set up of the units FanLite antenna and use of the radio secure with the aircraft.

b. It takes some planning and equipment to set up a sanctuary station. The best place for a sanctuary is in a rural environment away from motors, ignition systems, and power transformers that may interfere with transmissions. The minimum requirement is a VRC-100 with FanLite antenna (LFH230/1), KY-100, PSN-11, CYZ-10, battery box (CY-8515/ARC-201(V)), VRC-100 to KY-100 cable, STU III or other secure phone, and two personnel. The host building must have electrical power either 115VAC, 225V AC or 28V DC.

c. A focused or directional antenna helps. The FanLite can be set up in a directional mode. Commanders in theaters such as Bosnia for example would set up a Sanctuary in Germany or Hungary using a fixed base antenna aimed back into theater

d. Units do not have variables (keys) assigned for their radios and KY-100s. The division can provide keys to the units or the units can generate keys using their KY-100. Recommend that aviation brigades submit a formal request through their G6 for three key sets for the HF NOE-COM radio: Crypto variable (traffic encryption key) for the KY-100, ECCM variable (transmission security key) for the VRC-100, and Link Protection variable (transmission security key) for the VRC-100.

e. Early in the HF NOE COM program after long discussions with the aviation center and the G6 at the 101st Airborne Division, it was decided that the G6 was the proper place to manage frequencies, variables, and addresses for this radio. In retrospect this decision may have been wrong for the following reasons:

(1) The U.S. Army Signal Center, responsible for training of frequency managers in the Army, is not adding HF ALE/ECCM/Link Protection planning to their in-residence courses. Their rationale is that these waveforms are "aviation only."

(2) The U.S. Army Signal Center has no documented requirement for an HF ALE radio.

(3) There is no apparent upper level emphasis to provide G6s with time, training, and motivation to manage the ARC-220/VRC-100 radio.

The best place to manage the ARC-220/VRC-100 radio is in the aviation brigade S6 office. The aviation brigade S6 should also erect an antenna and place a VRC-100 radio on the air at all times for unit training and use 24 hours a day.

f. The aviation brigade S6 office and the battalion communications offices are typically composed of a Signal Officer and signal NCOs, "non-aviation." These soldiers typically are very familiar with ground communications equipment and wheeled (tracked) vehicle installations. I observed that more time should be allocated to interact with their major combat systems and aircraft. The battalion's avionics mechanics work through a different maintenance hierarchy than the vehicular and ground radio environment. There is a gap in continuity between the signal personnel who perform planning and operational testing on ground systems and aircraft operations personnel who perform the operational functions on the aircraft. It is recommended that additional emphasis be placed on the functional readiness of their combat communications systems i.e. SINCGARS, HAVEQUICK, and HF NOE COM on board the aircraft. Perhaps this can be motivated by requiring readiness reports on these major communications systems by aircraft on a periodic basis. This does not only include operations but training. Battalion and brigade level signal personnel should include crew member training on HAVEQUICK, SINCGARS, and HF NOE COM.

g. KY-100 and PSN-11 issues.

(1) We observed that the users universally dismount the VRC-100 from the HMMWV and installed them in various flight operations facilities while in garrison. In order to use the KY-100, they must either purchase a $1300 cable, remove the cable from the HMMWV and modify it, or make their own cable in order to use the KY-100 and PSN-11 with the VRC-100. The KY-100 does not have a mount outside the HMMWV, so users must create a mount or let it sit on top of the radio. The KY-100 does not send plain text data. The National Security Agency does not allow plain text data with the KY-100 hooked into the system. This will hinder the aircraft data communications in SASO and peacetime operations since the crew does not have an easy way to bypass the KY-100 in the aircraft. ALE cipher text data is the best mode of operation for this radio.

$1300 Cable

(2) The PSN-11 is necessary for both link protection and ECCM operations. The dismounted VRC-100 is often the net time server for ECCM nets and therefore should have a PSN-11 connected so that time clocks between the VRC-100 and the aircraft radios will enable synchronization. When dismounted from the HMMWV the PSN-11 must lay besides the radio or sit on top and its antenna must be placed outside for a clear view of satellites. The VRC-100 does not provide power for the PSN-11, requiring the use of the PSN-11's internal battery at all times.

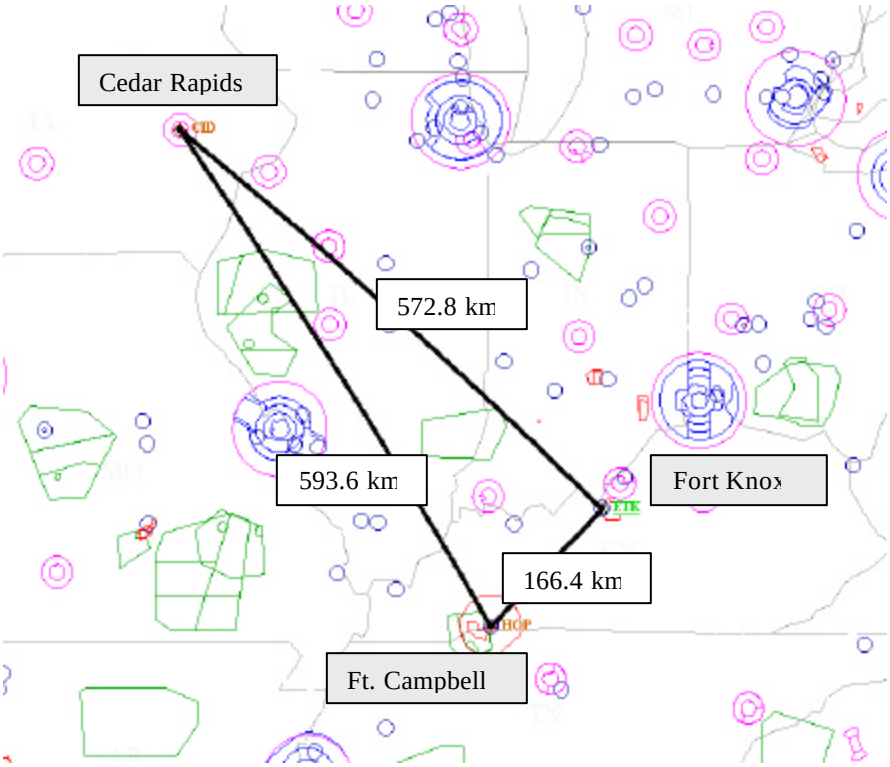
(3) The ARC-220 or VRC-100 was designed dismounting from its host HMMWV.. There was not enough money in the procurement plan to embed COMSEC, GPS, or provide a second set of cables for secure dismounted operations. Once the radio fielding is near completion it may be time to revisit embedding the COMSEC and GPS in the VRC-100 radio.

h. Remote operations. When set up in a field environment, the VRC-100 antenna must be located very close to the tactical operations center in order to run the RF cable into the radio in the TOC. This means that the TOC is in the near field of the RF emissions from the antenna, which is causing EMI problems with other equipment in the TOC. Further, since the FanLite antenna is so big it is very difficult to set it up without placing in an open field. TOCs are typically located in a tree line so locating TOCs with an HF antenna must be planned carefully. There is a remote capability for the VRC-100. The Program Manager has paid for a low speed binary interface to the radio, which could be used as a remote port for the radio, but no software is yet available to take advantage of this port. Remoting by some other existing means requires investigation.

Peter M. Bartosch
Vitronics Inc
Program Manager

Annex A Out of Theater Communications:

The following is the data collected during the Out of Theater Communications Experiment 18 through 29 September 2000 at Fort Campbell Kentucky



1. **Abbreviations and Acronyms:**
   - Campbell = Fort Campbell (HOP)
   - CID = Cedar Rapids IA, Communications Central facility of Rockwell Collins
   - Orange = waypoint
   - Yellow = waypoint
   - Red = waypoint
   - Blue = waypoint
   - Knox = Fort Knox (FTK)
   - ALE = Automatic Link Establishment
   - PT = Plain Text
   - CT = Cypher Text
   - ECCM = Electronic Counter Countermeasures (frequency hopping)

2. Addresses used throughout the experiment:
   - 7th Bn Base: T7Z101 (Hooker Base)
   - Sanctuary: CID (Cedar Rapids)

- Aircraft:
  - R23434 (Phoenix)
  - R23454 (Phoenix)
  - R647 (Varsity)
  - R673 (Varsity)

3. Schedule of events:

Date	Time	Type of Communications	Aircraft
26 Sep	1500-1600	ALE Voice PT	UH-60
26 Sep	1600-1735	ALE Voice CT	UH-60/CH-47
27 Sep	1500-1600	ALE Position CT	UH-60/CH-47
27 Sep	1715-1810	ALE Message CT	UH-60/CH-47
28 Sep	1600-1800	ECCM Voice CT	UH-60/CH-47
28 Sep	1900-2200	ECCM MSG CT	UH-60/CH-47

4. Distance Table

Waypoint	Waypoint	Distance NM
HOP	LZ Cat (FTK)	104
HOP	Orange	26
HOP	Yellow	45
HOP	Red	61
HOP	Blue	76
FTK	Blue	26
FTK	Red	43
FTK	Yellow	59
FTK	Orange	78
FTK	PZ Bear (HOP)	104
CID	Orange	361
CID	Yellow	358
CID	Red	357
CID	Blue	355
CID	LZ CAT (FTK)	356
CID	PZ Bear (HOP)	369

5. Ale Scan List used for the experiment

Frequency

3.1370
4.6415
4.7900
6.7210
7.3615
8.1715
10.8210
12.1680

6. Data Collection sheets:

a. 26 Sep 00. Campbell using VRC-100 with FanLite antenna. CID using VRC-100 with Fan Lite Antenna, aircraft using ARC-220 with installed antennas. KY-100 used as common crypto device

Time	Call To	By	Frequency	Position	Type Report	Remarks/Acknowledgement
	Day					
1500	Campbell	R26434	3.1370	HOP	ALE Voice PT	Weak at Campbell
1502	CID	R26434	10.8210	HOP	ALE Voice PT	Barely audible in aircraft
1510	Campbell	R26434	4.6150	Orange	ALE Voice PT	Weak at Campbell
1506	CID	R26434	10.8210	Orange	ALE Voice PT	Ok
1519	Campbell	R26434	10.8210	Yellow	ALE Voice PT	OK
1515	CID	R26434	10.8210	Yellow	ALE Voice PT	Ok
1527	Campbell	R26434	6.7120	Red	ALE Voice PT	OK
1523	CID	R26434	10.8210	Red	ALE Voice PT	Ok
1535	Campbell	R26434	6.7120	Blue	ALE Voice PT	Weak at Campbell
1531	CID	R26434	10.8210	Blue	ALE Voice PT	Ok
1548	Campbell	R26434	6.7120	Knox	ALE Voice PT	Weak at Campbell
1545	CID	R26434	10.8210	Knox	ALE Voice PT	Ok
1648	Campbell	R26434	10.8210	Knox	ALE Voice CT	OK
1654	CID	R26434	10.8210	Knox	ALE Voice PT	Ok
1705	Campbell	R26434	6.7210	Blue	ALE Voice CT	Garbled (failed)
1700	CID	R26434	10.8210	Blue	ALE Voice PT	Ok
1710	Campbell	R26434	8.1715	Red	ALE Voice CT	OK
1709	CID	R26434	10.8210	Red	ALE Voice PT	Weak but readable in aircraft
1720	Campbell	R26434	8.1715	Yellow	ALE Voice CT	Ok
1716	CID	R26434	10.8210	Yellow	ALE Voice PT	Ok
1728	Campbell	R26434	8.1715	Orange	ALE Voice CT	OK
1724	CID	R26434	10.8210	Orange	ALE Voice PT	OK
1738	Campbell	R26434	4.6415	HOP	ALE Voice CT	OK
1735	CID	R26434	10.8210	HOP	ALE Voice PT	OK
	Night					

Time	Call To	By	Frequency	Position	Type Report	Remarks/Acknowledgement
1930	Campbell	R23434	3.1370	HOP	ALE Voice PT	OK
1931	CID	R26434	6.7210	HOP	ALE Voice PT	Barely readable on aircraft
1042	Campbell	R26434	3.1370	Orange	ALE Voice PT	OK
1942	CID	R26434	6.7210	Orange	ALE Voice PT	Ok
1950	Campbell	R26434	3.1370	Yellow	ALE Voice PT	HOP linked but not audible from aircraft
1950	CID	R26434	4.7900	Yellow	ALE Voice PT	Ok
2003	Campbell	R26434	4.6415	Red	ALE Voice PT	Ok
1959	CID	R26434	4.7900	Red	ALE Voice PT	Ok
2013	Campbell	R26434	4.6415	Blue	ALE Voice PT	Weak at aircraft but readable
2006	CID	R26434	8.1715	Blue	ALE Voice PT	Weak at aircraft but readable
2021	Campbell	R26434	6.7210	FTK	ALE Voice PT	Ok
2018	CID	R26434	6.7210	FTK	ALE Voice PT	Ok
2052	Campbell	R26434	6.7210	FTK	ALE Voice CT	Weak partial garble/A/C no response
2051	CID	R26434	6.7210	FTK	ALE Voice CT	A/C weak
2109	Campbell	R26434	3.1370	Blue	ALE Voice CT	Weak partial gargle/A/C garbled
2104	CID	R26434	6.7210	Blue	ALE Voice CT	A/C weak but readable
2112	Campbell	R26434	3.1370	Red	ALE Voice CT	Garbled asked for repeat/A/C repeat no Ack
2112	CID	R26434	6.7210	Red	ALE Voice CT	Ok
2124	Campbell	R26434	3.1370	Yellow	ALE Voice CT	Garbled /A/C
2121	CID	R26434	4.7900	Yellow	ALE Voice CT	Ok
2133	Campbell	R26434	3.1370	Orange	ALE Voice PT	Garbled in CT got PT/A/C garbled
2130	CID	R26434	4.6415	Orange	ALE Voice CT	Garbled A/C garbled and weak
2140	Campbell	R26434	6.7120	HOP	ALE Voice CT	OK
2140	CID	R26434	4.7900	HOP	ALE Voice CT	Garbled but usable.
2053	Campbell	R673	8.1715	HOP	ALE Voice PT	Ok
2055	CID	R673				No link
2114	Campbell	R673	4.7900	Orange	ALE Voice PT	Ok
2116	CID	R673	6.7210	Orange	ALE Voice PT	Garble
2127	Campbell	R673	10.8210	Yellow	ALE Voice PT	Ok
2129	CID	R673	6.7210	Yellow	ALE Voice PT	OK
2137	Campbell	R673	3.1370	Red	ALE Voice PT	Ok
2139	CID	R673	6.7210	Red	ALE Voice PT	Ok
2147	Campbell	R673				No link
2151	CID	R673	6.7210	Yellow	ALE Voice PT	Ok
2159	Campbell	R673	4.6415	Orange	ALE Voice PT	OK

Time	Call To	By	Frequency	Position	Type Report	Remarks/Acknowledgement
2201	CID	R673	6.7210	Orange	ALE Voice PT	Ok
2223	Campbell	R673	4.6415	HOP	ALE Voice PT	Ok
2224	CID	R673	6.7210	HOP	ALE Voice PT	Ok

b. Summary of 26 Sep Data

26 Sep 00 ALE Plain Text and Cypher Text Voice, DAY

Receiving Station	No of Attempts	No Complete	% Complete	No Frequencies Used
In Theater (Campbell)	12	11	91.6	5
Out of Theater (CID)	12	12	100	1

26 Sep 00 ALE Plain Text and Cypher Text Voice, NIGHT

Receiving Station	No Attempts	No Complete	% Complete	No Frequencies used
In Theater (Campbell)	19	12	63.1	6
Out of Theater (CID)	19	15	78.9	3

c.. CID using a log periodic antenna focused towards Fort Campbell. All other parameters remain the same.

27 Sep 00 Data Collections Sheets. ALE Present Position and Message Reports Cypher Text

Time	Call To	Call From	Frequency	Position	Mode	Remarks
	Day					
1516	Campbell	R26454	4.6415	HOP	ALE PP CT	20.16.24 DR73595816
1518	CID	R26454	6.7210	HOP	ALE PP CT	20.18.30 DR79056672
1524	Campbell	R26454	4.6415	Orange	ALE PP CT	20.25.18 DR86009120
1527	CID	R26454	12.1680	Orange	ALE PP CT	20.27.32 DR92069985
1533	Campbell	R26454	8.1715	Yellow	ALE PP CT	20.33.55 ES16311705
1536	CID	R26454	12.1680	Yellow	ALE PP CT	20.36.13 ES15472327
1541	Campbell	R26454	8.1715	Red	ALE PP CT	20.41.10 ES29793737
1543	CID	R26454	10.8210	Red	ALE PP CT	20.43.25 ES37484469
1548	Campbell	R26454	8.1715	Blue	ALE PP CT	20.48.03 ES49805746
1550	CID	R26454	6.7210	Blue	ALE PP CT	20.50.54 ES50636438
1557	Campbell	R26454	8.1715	Knox	ALE PP CT	20.57.48 ES79308554
1600	CID	R26454	6.7210	Knox	ALE PP CT	21.00.32 ES86399164
1715	Campbell	R26454	6.7210	Knox	ALE MSG CT	Departing LZ CAT
1719	CID	R26454	4.6415	Knox	ALE MSG CT	Departing LZ CAT
1729	Campbell	R26454	4.7900	Blue	ALE MSG	Passing PL Blue

Time	Call To	Call From	Frequency	Position	Mode	Remarks
					CT	
1732	CID	R26454	6.7210	Blue	ALE MSG CT	Passing PL Blue
1735	Campbell	R26454	4.7900	Red	ALE MSG CT	Passing PL Red
1738	CID	R26454	4.6415	Red	ALE MSG CT	Passing PL Red
1744	Campbell	R26454	4.7900	Yellow	ALE MSG CT	Broke link 2d link Passing PL Yellow
1749	CID	R26454	4.6415	Yellow	ALE MSG CT	Passing PL Yellow
1752	Campbell	R26454	4.7900	Orange	ALE MSG CT	Passing PL Orange
1755	CID	R26454	4.6415	Orange	ALE MSG CT	Passing PL Orange
1804	Campbell	R26454	10.8210	HOP	ALE MSG CT	Arrival PZ Bear
1805	CID	R26454	4.6415	HOP	ALE MSG CT	Arrival PZ Bear
	Night					
2006	Campbell	R26434	10.8210	HOP	ALE MSG CT	Departing PZ Bear
2011	CID	R26434				Msg Abort
2020	Campbell	R26434	4.6415	Orange	ALE MSG CT	Passing PL Orange (slight garble)
2024	CID	R26434	6.7210	Orange	ALE MSG CT	Passing PL Orange
2029	Campbell	R26434	12.1680	Yellow	ALE MSG CT	Passing PL Yellow
2032	CID	R26434	6.7210	Yellow	ALE MSG CT	Passing PL Yellow
2036	Campbell	R26434	8.1715	Red	ALE MSG CT	Passing PL Red
2039	CID	R26434	3.1370	Red	ALE MSG CT	Passing PL Red
2043	Campbell	R26434	4.7900	Blue	ALE MSG CT	Passing PL Blue
2045	CID	R26434				Msg Abort
2053	Campbell	R26434	6.7210	Knox	ALE MSG CT	Arrival LZ CAT
2055	CID	R26434	6.7210	Knox	ALE MSG CT	Arrival LZ CAT

Time	Call To	Call From	Frequency	Position	Mode	Remarks
2143	Campbell	R26434	6.7210	Knox	ALE MSG CT	Departing LZ Cat
2144	CID	R26434	4.6415	Knox	ALE PP CT	ES90059507
2152	Campbell	R26434	3.1370	Blue	ALE MSG CT	Passing PL Blue
2155	CID	R26434	8.1715	Blue	ALE PP CT	ES54576162
2159	Campbell	R26434	3.1370	Red	ALE MSG CT	Passing PL Red
2201	CID	R26434	8.1715	Red	ALE MSG CT	Passing PL Red
2205	Campbell	R26434	3.1370	Yellow	ALE MSG CT	Passing PL Yellow
2207	CID	R26434	6.7210	Yellow	ALE MSG CT	Passing PL Yellow
2213	Campbell	R26434	4.7900	Orange	ALE MSG CT	Passing PL Orange
2214	CID	R26434	3.1370	Orange	ALE MSG CT	Passing PL Orange
2222	Campbell	R26434	12.1680	HOP	ALE MSG CT	Arrival PZ Bear
2225	CID	R26434				MSG Aborted interrupted by call from T7Z101
2002	Campbell	CH47	10.8210	HOP	ALE Msg CT	Departing PZ Bear
2004	CID	CH47	10.8210	HOP	ALE Msg CT	Departing PZ Bear
2014	Campbell	CH47	12.1680	Orange	ALE Msg CT	Passing PL Orange
2015	CID	CH47	3.1370	Orange	ALE Msg CT	Passing PL Orange
2021	Campbell	CH47	12.1680	Yellow	ALE Msg CT	Passing PL Yellow
2022	CID	CH47	3.1370	Yellow	ALE Msg CT	Passing PL Yellow
2029	Campbell	CH47			ALE Msg CT	No link
2029	CID	CH47	3.1370	Red	ALE Msg CT	Passing PL Red
2036	Campbell	CH47	3.1370	Blue	ALE Msg CT	Passing PL Blue
2036	CID	CH47	6.7210	Blue	ALE Msg	Passing PL Blue

Time	Call To	Call From	Frequency	Position	Mode	Remarks
					CT	
2048	Campbell	CH47	4.7900	Knox	ALE Msg CT	Arrival LZ Cat
2048	CID	CH47	6.7210	Knox	ALE Msg CT	Arrival LZ Cat
2058	Campbell	CH47	4.6415	Knox	ALE Msg CT	Departing LZ Cat
2058	CID	CH47	3.1370	Knox	ALE Msg CT	Departing LZ Cat
2104	Campbell	CH47	4.6415	Blue	ALE Msg CT	Passing PL Blue
2106	CID	CH47	3.1370	Blue	ALE Msg CT	Passing PL Blue
2111	Campbell	CH47	3.1370	Red	ALE Msg CT	Passing PL Red partial garble
2113	CID	CH47	6.7210	Red	ALE Msg CT	Passing PL Red
2119	Campbell	CH47	3.1370	Yellow	ALE Msg CT	Passing PL Yellow partial garble
2118	CID	CH47	6.7210	Yellow	ALE Msg CT	Passing PL Yellow
2125	Campbell	CH47	3.1370	Orange	ALE Msg CT	Passing PL Orange partial garble
2126	CID	CH47	6.7210	Orange	ALE Msg CT	Passing PL Orange
2136	Campbell	CH47	6.7210	HOP	ALE Msg CT	Arrival PZ Bear
2142	CID	CH47	8.1715	HOP	ALE Msg CT	Arrival PZ Bear

27 Sep 00 Summary of Activity, DAY

Receiving Station	No of Attempts	No Complete	% Complete	No Frequencies Used
In Theater (Campbell)	12	12	100	5
Out of Theater (CID)	12	12	100	4

27 Sep 00 Summary of Activity, NIGHT

Receiving Station	No of Attempts	No Complete	% Complete	No Frequencies used
In Theater (Campbell)	24	21	87.5	7
Out of Theater (CID)	24	21	87.5	6

d. Communications Central using a VRC-100 and a Log Periodic antenna focused towards the area of operations. All other parameters remain constant

28 Sep 2000 ECCM Voice, Message, Cypher Text

Time	Call to	Call From	Center Frequency	Position	Mode	Remarks
	Day					
1600	Campbell	R26434	10.8210	HOP	ECCM Voice CT	Ok
1602	CID	R26434	10.8210	HOP	ECCM Voice CT	Ok very good
1617	Campbell	R26434	10.8210	Orange	ECCM Voice CT	Campbell heard but A/C did not hear ACK
1618	CID	R26434	10.8210	Orange	ECCM Voice CT	Ok very good
1626	Campbell	R26434	10.8210	Yellow	ECCM Voice CT	Campbell heard but A/C did not hear ACK
1627	CID	R26434	10.8210	Yellow	ECCM Voice CT	Ok very good
1633	Campbell	R26434	10.8210	Red	ECCM Voice CT	Campbell heard but A/D did not hear ACK
1634	CID	R26434	10.8210	Red	ECCM Voice CT	Ok excellent
1641	Campbell	R26434	10.8210	Blue	ECCM Voice CT	Campbell heard but A/C did not hear ACK
1642	CID	R26434	10.8210	Blue	ECCM Voice CT	Ok excellent
1654	Campbell	R26434	10.8210	Knox	ECCM Voice CT	Campbell heard but A/C heard garbled
1655	CID	R26434	10.8210	Knox	ECCM Voice CT	OK excellent
1745	Campbell	R26434	10.8210	Knox	ECCM Voice CT	Campbell heard but A/C was garbled
1746	CID	R26434	10.8210	Knox	ECCM Voice CT	Ok excellent
1755	Campbell	R26434	10.8210	Blue	ECCM Voice CT	Campbell heard but A/C did not get ACK
1756	CID	R26434	10.8210	Blue	ECCM Voice CT	Ok excellent
1801	Campbell	R26434	10.8210	Red	ECCM Voice CT	Campbell heard A/C ok but a little garbled
1803	CID	R26434	10.8210	Red	ECCM Voice CT	Ok excellent
1807	Campbell	R26434	10.8210	Yellow	ECCM Voice CT	Campbell heard but A/C did not get ACK
1808	CID	R26434	10.8210	Yellow	ECCM Voice CT	Ok excellent
1815	Campbell	R26434	10.8210	Orange	ECCM Voice CT	Campbell heard but A/C did not get ACK
1816	CID	R26434	10.8210	Orange	ECCM Voice CT	OK very good
1824	Campbell	R26434	10.8210	HOP	ECCM Voice CT	Campbell heard and A/C understood Ack some garble
1825	CID	R26434	10.8210	HOP	ECCM Voice CT	Ok very good
1641	Campbell	R647	10.8210	HOP	ECCM Voice CT	Ok

Time	Call to	Call From	Center Frequency	Position	Mode	Remarks
1642	CID	R647	10.8210	HOP	ECCM Voice CT	CID heard ok A/C did not hear ACK
1656	Campbell	R647	10.8210	Orange	ECCM Voice CT	Ok
1658	CID	R647	10.8210	Orange	ECCM Voice CT	No contact either station
1703	Campbell	R647	10.8210	Yellow	ECCM Voice CT	Campbell heard ok A/C did not get ACK
1704	CID	R647	10.8210	Yellow	ECCM Voice CT	CID was garbled A/C made the report
1711	Campbell	R647	10.8210	Red	ECCM Voice CT	Campbell head ok A/C did not get ACK
1713	CID	R647	10.8210	Red	ECCM Voice CT	Ok both ends
1719	Campbell	R647	10.8210	Blue	ECCM Voice CT	Campbell heard ok A/C did not get ACK
1720	CID	R647	10.8210	Blue	ECCM Voice CT	OK both ends
1731	Campbell	R647	10.8210	Knox	ECCM Voice CT	Campbell heard ok A/C did not get ACK
1732	CID	R647	10.8210	Knox	ECCM Voice CT	Ok both ends
1734	Campbell	R647	10.8210	Knox	ECCM Voice CT	Campbell heard ok A/c did not get ACK
1735	CID	R647	10.8210	Knox	ECCM Voice CT	No response either end
1743	Campbell	R647	10.8210	Blue	ECCM Voice CT	Campbell garbled A/C did not get ACK
1744	CID	R647	10.8210	Blue	ECCM Voice CT	Ok
1750	Campbell	R647	10.8210	Red	ECCM Voice CT	Campbell garbled A/C did not get ACK
1750	CID	R647	10.8210	Red	ECCM Voice CT	Ok
1756	Campbell	R647	10.8210	Yellow	ECCM Voice CT	Campbell received ok A/C did not get ACK
1756	CID	R647	10.8210	Yellow	ECCM Voice CT	CID received OK A/C did not get ACK
1804	Campbell	R647	10.8210	Orange	ECCM Voice CT	Campbell received ok A/C did not get ACK
1805	CID	R647	10.8210	Orange	ECCM Voice CT	Ok
1813	Campbell	R647	10.8210	HOP	ECCM Voice CT	Ok
1815	CID	R647	10.8210	Hop	ECCM Voice CT	CID received ok A/C did not get ACK
	Night					
1926	Campbell	R26434	10.8210	HOP	ECCM Voice CT	good
1927	CID	R26434	10.8210	HOP	ECCM Voice CT	Very Good
1940	Campbell	R26434	10.8210	Orange	ECCM MSG CT	Ok
1940	CID	R26434	10.8210	Orange	ECCM MSG CT	OK

Time	Call to	Call From	Center Frequency	Position	Mode	Remarks
1948	Campbell	R26434	10.8210	Yellow	ECCM MSG CT	Missed
1948	CID	R26434	10.8210	Yellow	ECCM MSG CT	Ok
1955	Campbell	R26434	10.8210	Red	ECCM MSG CT	Ok
1955	CID	R26434	10.8210	Red	ECCM MSG CT	Ok
2001	Campbell	R26434	10.8210	Blue	ECCM MSG CT	ES24983182
2001	CID	R26434	10.8210	Red	ECCM PP CT	ES24953482
2012	Campbell	R26434	10.8210	Knox	ECCM MSG CT	Sync Error
2012	CID	R26434	10.8210	Knox	ECCM MSG CT	Ok
2135	Campbell	R26434	10.8210	Knox	ECCM MSG CT	No contact
2135	CID	R26434	10.8210	Knox	ECCM MSG CT	No contact
2145	Campbell	R26434	10.8210	Blue	ECCM MSG CT	No contact
2146	CID	R26434	10.8210	Blue	ECCM MSG CT	No contact
2155	Campbell	R26434	4.7900	Red	ALE Voice PT	OK
2155	CID	R26434	10.8210	Red	ECCM MSG CT	OK
2203	Campbell	R26434	4.7900	Yellow	ALE Voice PT	OK
2203	CID	R26434	10.8210	Yellow	ECCM MSG CT	OK
2209	Campbell	R26434	4.7900	Orange	ALE Voice PT	OK
2210	CIC	R26434	10.8210	Orange	ECCM MSG CT	No contact
2214	Campbell	R26434	3.1715	HOP	ALE Voice PT	Ok
2218	CID	R26434	10.8210	HOP	ECCM MSG CT	OK
2042	Campbell	R647	10.8210	HOP	ECCM MSG CT	Departing PZ Bear
2042	CID	R647	10.8210	HOP	ECCM MSG CT	No contact
2057	Campbell	R647	10.8210	Orange	ECCM MSG CT	Passing PL Orange
2057	CID	R647	10.8210	Orange	ECCM MSG CT	Missed
2106	Campbell	R647	10.8210	Yellow	ECCM MSG CT	Missed
2106	CID	R647	10.8210	Yellow	ECCM MSG CT	Missed
2114	Campbell	R647	10.8210	Red	ECCM MSG CT	Passing PL Red
2114	CID	R647	10.8210	Red	ECCM MSG CT	Missed
2122	Campbell	R647	10.8210	Blue	ECCM MSG CT	Passing PL Blue
2122	CID	R647	10.8210	Blue	ECCM MSG CT	Missed
2131	Campbell	R647	10.8210	Knox	ECCM MSG CT	Missed
2131	CID	R647	10.8210	Knox	ECCM MSG CT	Missed
2137	Campbell	R647	10.8210	Knox	ECCM PP CT	Sync error
2137	CID	R647	10.8210	Knox	ECCM PP CT	Missed
2148	Campbell	R647	10.8210	Blue	ECCM PP CT	No pos data
2148	CID	R647	10.8210	Blue	ECCM PP CT	No pos data
2154	Campbell	R647	10.8210	Red	ECCM PP CT	No Pos data
2154	CID	R647	10.8210	Red	ECCM PP CT	No Pos data
2200	Campbell	R647	10.8210	Yellow	ECCM PP CT	No pos data
2200	CID	R647	10.8210	Yellow	ECCM PP CT	No pos data
2206	Campbell	R647	10.8210	Orange	ECCM PP CT	No pos data
2206	CID	R647	10.8210	Orange	ECCM PP CT	No pos data

Time	Call to	Call From	Center Frequency	Position	Mode	Remarks
2216	Campbell	R647	10.8210	HOP	ECCM PP CT	No pos data
2216	CID	R647	10.8210	HOP	ECCM PP CT	No pos data

28 Sep 00 Summary of Data Collected

Receiving Station	No of Attempts	No Complete	% Complete	No Frequencies Used
In Theater (Campbell)	24	13*	54.1	1
Out of Theater (CID)	24	22*	91.7	1

28 Sep 00 Summary of Data Collected

Receiving Station	No of Attempts	No Complete	% Complete	# Frequencies used
In Theater (Campbell)	24	12	50.0	1
Out of Theater (CID)	24	10	41.7	1

*The aircraft transmission were understood at HOP and CID but the aircrew could not understand the acknowledgement by the ground station. These one way reports were credited with ½ completion.